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NMR imaging of congenital intracranial germinal layer neoplasms

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Summary. NMR images in five patients with surgically proved, congenital germinal layer intracranial neoplasms (two dermoid and three epidermoid tumors) were reviewed. The dermoids were typically midline (suprasellar or parapineal) masses with sharply-defined margins. Relaxation times were variable, but if fat was present, T_1 was decreased, and T_2 was increased. The epidermoids were off the midline (cerebellopontine angle, temporal lobe, frontal lobe) masses with generally long T_1 and T_2 relaxation times. Obstructive hydrocephaly was noted in one patient, and tumor to ventricular communication was demonstrated in another.

Key words: NMR - MRI - epidermoid tumors - dermoid tumors

Congenital neoplasms of the epidermoid and dermoid varieties are unusual, constituting less than 2% of all intracranial neoplasms [1]. In the diagnosis of these tumors, the plain skull film, pneumoencephalographic, nuclear tracer study, angiographic, and CT findings have been published at length [4-11]. This is a report of the nuclear magnetic resonance (NMR) characteristics of such tumors as encountered at Hammersmith Hospital.

Materials and methods

The NMR images of five patients with surgically proved, congenital germinal layer intracranial neoplasms were reviewed in a retrospective study. In this group were two dermoid and three epidermoid tumors.

Table 1. NMR pulse sequences

	TR (msec)	$T_{I/E}$ (msec)
RFID	1000	
$IR_{1400/400}$	1400	400
$IR_{1200/200}$	1200	200
$IR_{1800/600}$	1800	600
$SE_{1080/40}$	1080	40
$SE_{1160/80}$	1160	80

Table 2. Lesion distribution

Age (years)	Sex	Location	Histology
12	Fe	Suprasellar	Dermoid
14	M	Parapineal	Dermoid
33	Fe	Frontal lobes	Epidermoid
40	M	Cerebellopontine angle	Epidermoid
63	M	Temporal lobe	Epidermoid

Table 3. NMR findings

Finding	Incidence
1. Mass effect	5
2. Lesion margins	
a) Well-defined	4
b) Ill-defined	1
3. Hydrocephalus	1
4. Decreased T_1 and increased T_2 (Dermoid)	1
5. Mixed T_1 and T_2 values (Dermoid)	1
a) Decreased T_1 and increased T_2	
b) Increased T_1 and T_2	
c) Increased T_1 and decreased T2	
6. Increased T_1 and T_2 (Epidermoid)	2
7. Increased T_1 and T_2 with altered ventricle (Epidermoid)	1

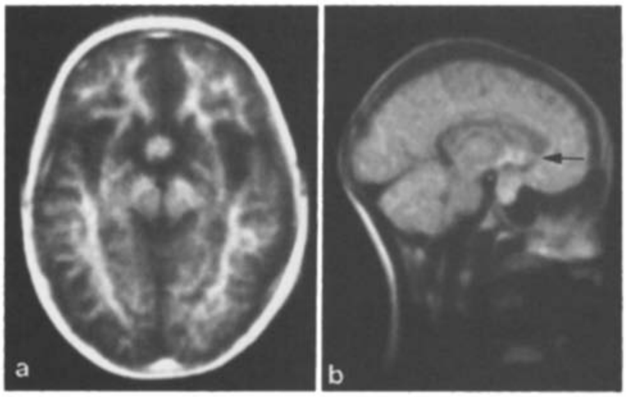

Fig. 1 a and b. a IR – note suprasellar mass of short T_1. **b** SE – observe long T_2 mass within sella turcica and suprasellar cistern. *Arrow* indicates probable peritumoral edema. Dermoid

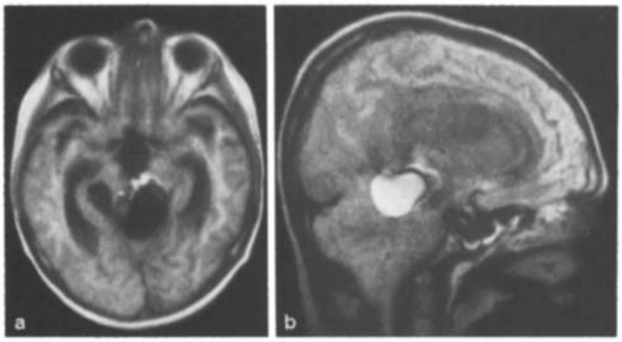

Fig. 2 a and b. a IR – mixed relaxation time mass at quadrigeminal cistern with dilated ventricles. **b** SE – mixed relaxation time mass at posterior third ventricle. Dermoid

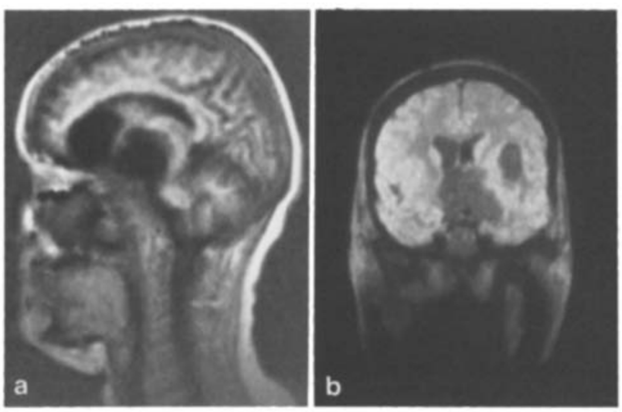

Fig. 3 a and b. a IR – note multilocular long T_1 frontal and suprasellar mass. **b** SE – observe signal intensity of right lateral ventricle, and relate it to tumor and left lateral ventricle. Appearance of multiple lesions created by slice artifact of lobular mass

One dermoid had initial surgery and radiotherapy 2 years prior to the NMR images. Two of the epidermoid tumors had surgery 14 and 16 years prior to NMR study. These were recurrences of the initial primary lesions.

All studies were conducted with a prototype NMR unit based on a cryogenic magnet operating at 0.15T. Free induction decay (RFID), inversion recovery (IR), and spin-echo (SE) pulse sequences were used (Table 1).

Results

The distribution according to age, sex, anatomic location, and histology is recorded in Table 2. Males were more common, and dermoids were younger. Dermoids exhibited midline preferences, but epidermoids displayed a lateral tendency.

The NMR image paramters evaluated and the results of those evaluations are listed in Table 3. While mass effect, lesion margins, and hydrocephalus are self-evident, the relaxation times are less clear.

No lesion had a completely homogeneous relaxation time. All lesions had at least some area of high intensity signal (HIS) of increased T_2 on SE (Fig. 1). Areas of HIS on TR indicating short T_1 were seen in both dermoids, and T_2 was increased on SE producing a HIS in these same areas (Fig. 2). All epidermoid tumors had increased T_1 with low intensity signal (LIS) an IR (Fig. 3). In one epidermoid the relaxation time of one lateral ventricle was equal to that of the contiguous frontal lobe tumor and different from that of the contralateral ventricle (Fig. 3).

Discussion

Intracranial dermoid and epidermoid tumors are histologically benign, congenital neoplasms which result from aberrations of closure of the dorsal neural tube in which mesoderm and/or ectoderm respectively are included in the fusion. This occurs at the 3rd to 5th gestational weeks, but it seems that earlier abnormalities produce lesions closer to the midline [2].

Since they are physically soft, histologically benign, and biologically slow growing, their size may be quite advanced before producing sufficient signs and symptoms to lead to a clinical evaluation and diagnosis. Rarely this insidious course becomes precipitous due to lesion rupture and secondary chemical meningitis. This may generate seizures, coma, or even death. Although generally surgically amenable, recurrence may develop [2], as was seen in three cases in this series. Follow-up examinations without ionizing radiation or invasive techniques then would be desirable. This is achieved with NMR.

Epidermoids tended to lateral locations (cerebellopontine angle, temporal lobe, frontal lobe), and dermoids were near the midline (parapineal and suprasellar). The most common location of dermoid tumors (midline posterior fossa) was not represented. In general, these features corresponded to such lesions at large [1].

Since IR pulse sequences provide superior gray-white matter contrast and excellent anatomic detail [12,13], enlargement, deformity, or displacement of the cerebrospinal fluid (CSF) spaces (ventricles, cisterns, subarachnoid space) readily is seen (Figs. 2 and 3). More subtle signs of disease, such as loss of gray-white matter contrast and displacement of the gray-white matter interface, may also be identified as evidence of edema or masses repectively. Although the anatomic detail was displayed more vividly with NMR, the technique of image analysis was very similar to that of CT. Masses were visible in all cases, but the impact on adjacent anatomic structures was relatively mild, presumably because of their slow growth and cystic nature, which probably also are responsible for the generally well defined margins of these tumors.

Epidermoid tumors have a collagen connective tissue wall, a stratified squamous epithelial lining, and a lumen filled with debris, which is an essentially homogeneous mixture of keratin and cholesterin [1]. Cholesterin is a lipid, and since lipids produce a HIS with IR due to a short T_1 and HIS with SE because of long T_2 [14], it would be expected that these would be the findings in epidermoid tumors, but this was not the case. All epidermoids had low intensity signals (LIS) with IR due to long T_1. It must be assumed, therefore, that there is such a thing as net relaxation time (NRT) in tissue mixtures. A similar proposition has been recognized with CT [9].

When placed in a liquid medium (CSF), the cholesterin may separate from the keratin to produce fat-fluid levels which become visible on plain films and CT. In one case in this series the relaxation times of one lateral ventricle were the same as the frontal lobe epidermoid and different from the other lateral ventricle. While this indicated ventricular communication, it was not the HIS which would be expected with a pure lipid. It would seem, therefore that either this separation does not always occur, its development is time related, or the cholesterin is insufficient in quantity to produce a separate collection.

Dermoid tumors differ by the addition of mesodermal components, including fat [1], which, if present, produces the HIS of short T_1 and long T_2. This was observed in at least some areas of both dermoids. It should be noted, however, that hemorrhage also produces short T_1 and long T_2, and this could be confusing. While CT may resolve this diagnostic dilemma, hematomas may become isodense or even hypodense on CT before discernible change of NMR relaxation times occurs.

Conclusions

1. NMR is a sensitive tool in the detection of intracranial dermoid and epidermoid tumors and their complications:
   Hydrocephalus
   Ventricular communication
2. Satisfactory evaluation requires both IR and SE pulse sequences.
3. CT and NMR are complementary in the diagnosis of these neoplasms.

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